

**Implementation of Fissile Exempt Materials in Support of Decommissioning a Former Nuclear Fuel Manufacturing Site - 11388**

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**ABSTRACT**

As part of decommissioning a former nuclear fuel manufacturing site, there are soil and debris with residual enriched uranium. Enriched uranium falls under the category of Special Nuclear Materials (SNM) under Nuclear Regulatory Commission (NRC) regulations, which impose additional nuclear safety controls proportional to the amount of enriched uranium materials. Given the large volumes of waste material that will be generated with low concentrations of enriched uranium, a request for Fissile Exempt materials following NRC and Department of Transportation (DOT) regulations and guidance was submitted and approved. Fissile Exempt materials meet established NRC criteria and safety evaluations such that no additional nuclear safety measures (criticality or security) are needed to safely handle, transport and dispose of these materials. The use of Fissile Exempt materials will allow decommissioning to be performed more efficiently and reduce unnecessary regulatory burden associated with decommissioning without impacting safety of workers or the public.

**INTRODUCTION**

Decommissioning of a former nuclear fuel manufacturing site will require the excavation, packaging, and shipment of large volumes of contaminated soils and debris. The current radioactive material licenses for the site incorporate possession limits for enriched uranium, based on restrictive mass limits, which place significant constraints on implementation of decommissioning of the site where the identified contaminant is enriched uranium at very low concentrations. The addition of Fissile Exempt materials is focused on safety and control of waste materials from decommissioning operations containing low concentrations of special nuclear material residues.

The primary basis for Fissile Exempt materials is to facilitate handling, transportation and disposal of large volumes of soil containing low concentrations of SNM. NRC regulations pertaining to SNM, particularly 10 CFR Part 70 and 73 were established primarily for the safe handling and control of various quantities of stock material (i.e., SNM product) for the fuel cycle. Low concentration residues being processed for transportation and disposal as waste do not pose the same hazards as stock material and therefore should not require the same level of regulatory control in order to maintain comparable safety. Due to the limited number of active special nuclear materials (SNM) licensed sites undergoing decommissioning, the NRC has deferred changes in the regulations. The current practice is to address decommissioning regulatory issues through the amendment process while applying potential exemptions as appropriate.

## **BACKGROUND**

Fissile Exempt materials is based on the following limitations noted as “exemption from classification as fissile material” and “fissile material exception” as incorporated in NRC regulation (10 CFR 71.15) and Department of Transportation (DOT) regulation (49 CFR 173.453), respectively for the management and transportation of radioactive material. For transportation, SNM can be exempt from classification as “fissile” if the material meets a specific ratio of fissile to non-fissile material mass. Instead of a mass limit for U-235, Fissile Exempt materials incorporates the aforementioned fissile to non-fissile material mass ratio to ensure safety during decommissioning operations. It is expected that the vast majority of waste generated during decommissioning at the site will meet the Fissile Exempt criteria as is due to the relatively low concentrations of uranium identified during characterization.

A summary of relevant technical evaluations by the NRC associated with transportation requirements for Fissile Exempt materials and basis for current regulations is provided below.

In February 1997, NRC completed an emergency final rulemaking (62 FR 5907, February 10, 1997) to address the potential for inadequate criticality safety in certain shipments of exempted quantities of fissile material. The emergency rule revised portions of 10 CFR Part 71 that limited the consignment mass for fissile material exemptions and restricted the presence of beryllium, deuterium, and graphite moderators. The NRC solicited public comments on the emergency rule, and comments were received that supported the need for the emergency rule, but argued that the restrictions imposed therein were excessive. For example, several commenters noted that they had shipped wastes that violated the emergency rule in the past without any problems and that the new restrictions would at least double the number of waste shipments, thereby increasing costs, decreasing worker safety, and increasing the risk of accidents.

The NRC had Oak Ridge National Laboratory study the issue in greater detail and in July 1998, NUREG/CR-5342, Assessment and Recommendations for Fissile-Material Packaging Exemptions and General Licenses Within 10 CFR Part 71 was issued. The results of this study generally indicated that the likelihood of accumulating sufficient fissile material to achieve criticality is highly improbable; such an occurrence would require the complete loss of packaging and an idealized spherical configuration under normal and/or accident conditions. One of the scenarios evaluated in this study was 100% enriched U-235 homogeneously mixed with silicon dioxide and water. This matrix was selected since it could represent dirt, glass or common solid waste. In addition, a new ratio of fissile to non-fissile material was recommended for Fissile Exempt material of one (1) gram fissile to 2,000 grams non-fissile for low concentration solid materials.

The NRC agreed with the suggested changes in NUREG/CR-5342 with respect to exemption from classification as fissile material. In March 2001, the NRC provided analyses and technical evaluations related to Fissile Exempt materials for transportation in Commission Paper SECY-2001-0035, Proposed Rule for Revising 10 CFR Part 71 for Compatibility with IAEA Transportation Safety Standards [TS-R-1], and for Making Other NRC-Initiated Changes. More specifically, Issue 16 of the Commission Paper addressed fissile material exemptions. This is the

basis for the current regulations addressing low concentration solid Fissile Exempt materials in the NRC and DOT. Pertinent sections of these regulations are provided as reference below.

10 CFR 71.15 Exemption from classification as fissile material (Excerpt from Regulation)

*Fissile material meeting the requirements of at least one of the paragraphs (a) through (f) of this section are exempt from classification as fissile material and from the fissile material package standards of §§71.55 and 71.59, but are subject to all other requirements of this part, except as noted.*

(c)

- (1) *Low concentrations of solid fissile material commingled with solid non-fissile material, provided that:*
  - (i) *There is at least 2000 grams of solid non-fissile material for every gram of fissile material, and*
  - (ii) *There is no more than 180 grams of fissile material distributed within 360 kg of contiguous non-fissile material.*
- (2) *Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but must not be included in determining the required mass of solid non-fissile material.*

49 CFR 173.453 Fissile materials-exceptions (Excerpt from Regulation)

*Fissile materials meeting the requirements of at least one of the paragraphs (a) through (f) of this section are excepted from the requirements of this subpart for fissile materials, including the requirements of §§173.457 and 173.459, but are subject to all other requirements of this subpart, except as noted.*

(d) *Low concentrations of solid fissile material commingled with solid non-fissile material, provided that:*

- (1) *There is at least 2000 grams of non-fissile material for every gram of fissile material, and*
- (2) *There is no more than 180 grams of fissile material distributed within 360 kg of contiguous non-fissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but must not be included in determining the required mass of solid non-fissile material.*

In addition to evaluations related to criticality safety to transportation, similar studies have been performed for disposal of similar materials. In November 1994, NRC issued NUREG/CR-6284, Criticality Safety Criteria for License Review of Low-Level Waste Facilities. This study provided nuclear criticality safety levels for disposal of materials in terms of areal density (grams per square foot). Later the NRC issued NUREG/CR-6505, The Potential for Criticality Following Disposal of Uranium at Low-Level Waste Facilities in June 1997. This study provided nuclear criticality safety levels for disposal of materials in terms of concentration limits. NUREG/CR-6505 is the technical basis for the current WAC for disposal of SNM. The WAC for enriched uranium comparable to transportation requirements includes a limit for U-235

concentration of 70 Bq/g (1,900 pCi/g) for enrichments less than 10% or 44 Bq/g (1,190 pCi/g) for enrichments of 10% or greater.

Since there are different criteria for transportation (mass ratio) and disposal of low concentration enriched uranium (radionuclide concentration), a comparison will be performed. Conversion of the of transportation requirements from mass ratio (2,000 grams non-fissile for every gram fissile) to radionuclide concentration results in a U-235 concentration of 40 Bq/g (1,080 pCi/g). Since this concentration is less than the WAC for enriched uranium, the Fissile Exempt concentration for transportation is the most conservative and limiting value. Furthermore, materials that meet the transportation requirements for Fissile Exempt will also be acceptable for disposal since U-235 concentrations will be less than WAC limits.

In addition, shipments of decommissioning waste must adhere to the definition of Fissile Exempt. Otherwise, the shipments would have to be made in NRC approved containers for the transport of fissile material. Currently, there are no appropriate licensed containers for the shipment of large volumes of low concentration SNM materials. The definition of Fissile Exempt is based on the assumption that the fissile material is pure U-235 (i.e. 100% enrichment), therefore the applicable regulations for the transport of the waste from the nuclear criticality safety standpoint are conservative for any material that may be encountered during decommissioning at the site.

Another potential concern regarding Fissile Exempt materials is security. In NRC Regulatory Guide 5.59, Standard Format and Content for a Licensee Physical Security Plan for the Protection of Special Nuclear Material of Moderate or Low Strategic Significance states that the quantity of concern for gross theft is estimated as 75 kg of U-235. At the Fissile Exempt concentration (40 Bq/g or 1,080 pCi/g for U-235), this amount converts to approximately 165 tons of waste material. As part of the evaluation for WAC and an Order exempting the disposal facility from requirements relative to possession of SNM published in 68FR74986-74988, the NRC stated:

*Safeguarding SNM against diversion or sabotage is not considered a significant issue because of the diffuse form of the SNM in waste meeting the conditions specified.*

Since the Fissile Exempt criteria for transportation is less than the WAC, it stands to reason that material meeting Fissile Exempt should not be considered a significant security issue since diversion or sabotage of low concentration material is not a practical threat. Therefore, once material has been demonstrated to meet the noted limitations of Fissile Exempt, no additional physical protection measures under 10 CFR Part 73 for SNM would be required.

## **IMPLEMENTATION OF FISSILE EXEMPT**

Processes involving Fissile Exempt materials will be done in accordance with NRC license conditions, Site procedures and plans. The approach will be as follows. The amount and concentration of SNM for an area will be determined prior to decommissioning operations. This data will determine the volumes of soil or materials that are acceptable to be removed for nuclear

criticality safety. This is a combination of concentration and mass criteria for U-235. No criticality safety controls will be required if volumetric concentrations of U-235 are less than 70 Bq/g (1,900 pCi/g) with less than 10% enrichment or less than 44 Bq/g (1,190 pCi/g) with greater than 10% enrichment. No criticality controls will be required if the mass of U-235 in the materials being handled is less than 350 grams. As materials are excavated or removed from the area and taken into possession, they will be placed into appropriate containers. Confirmation samples and surveys will be performed and the concentration and mass of SNM for the container will be calculated and added to the primary SNM inventory under the current license category for SNM. These materials are also subject to nuclear criticality controls and physical security requirements as necessary according to license conditions and the Site Physical Security Plan.

Once the packaged materials have been determined to meet the Fissile Exempt criteria, they will be transferred from the standard SNM inventory to a waste inventory, and the license category will change from SNM to Fissile Exempt. In addition, once materials have been categorized as Fissile Exempt, they would no longer be subject to nuclear criticality controls, physical security requirements or mass (gram) possession limits. This process will maintain sufficient documentation and control of the material to ensure nuclear criticality safety during decommissioning operations, security, and accountability of the material while it remains at the Site. The primary SNM inventory will represent the standard SNM license category with a mass based limit, and the waste inventory will represent SNM waste with a fissile to non-fissile ratio based limit as opposed to a gram limit. Reporting of SNM transactions and inventory to Nuclear Materials Management & Safeguards System (NMMSS) will be conducted in accordance with NRC regulations.

For comparison, the Site-specific soil DCGL is 21 Bq/g (557 pCi/g) total uranium, of which approximately 1 Bq/g (24 pCi/g) is attributed to U-235, whereas the Fissile Exempt criterion is U-235 concentration of 40 Bq/g (1,080 pCi/g). The CE Windsor Site soil to be addressed under decommissioning contain an average concentration of U-235 approximately 2 Bq/g (60 pCi/g) and maximum of about 185 Bq/g (5,000 pCi/g) from a population of 1,500 data points. Furthermore, only 0.5% of the data points exceed U-235 concentration of 40 Bq/g (1,080 pCi/g). It is clear that a significant amount waste generated during decommissioning will meet this criterion "as is" since the Fissile Exempt criterion is 45 times larger than the DCGL equivalent for U-235. In addition, it is anticipated that only trace amounts of lead, beryllium, graphite, and hydrogenous material enriched in deuterium would be encountered during decommissioning operations, if at all, that could potentially be present in the waste materials.

## **SUMMARY**

This evaluation has shown that low concentration enriched uranium waste materials do not pose a criticality or security concern and that the NRC has approved or allowed similar activities with these types of materials. The use of Fissile Exempt materials allows decommissioning operations to proceed more efficiently with no adverse consequences to security or safety. In addition, it will allow more effective transportation of waste to the disposal facility which will greatly reduce the risk of industrial and traffic accidents. The use of Fissile Exempt materials as part of decommissioning has been successfully implemented for a large volume of waste at a former nuclear fuel manufacturing site. This process provides effective solution to ensure

nuclear criticality safety and security and reduce potential schedule delays during decommissioning activities.